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(54) **BRAKE BOOSTER DEVICE FOR A BRAKING SYSTEM OF A VEHICLE, AND METHOD FOR MANUFACTURING A BRAKE BOOSTER DEVICE FOR A BRAKING SYSTEM OF A VEHICLE**

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(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

2,341,318 A * 2/1944 Forbes B60T 11/224 417/216
3,559,406 A 2/1971 Gardner Delbert
(Continued)

FOREIGN PATENT DOCUMENTS

CN 101242978 A 8/2008
CN 102042357 A 5/2011
(Continued)

OTHER PUBLICATIONS

International Search Report for PCT/EP2012/065408, dated Dec. 21, 2012.

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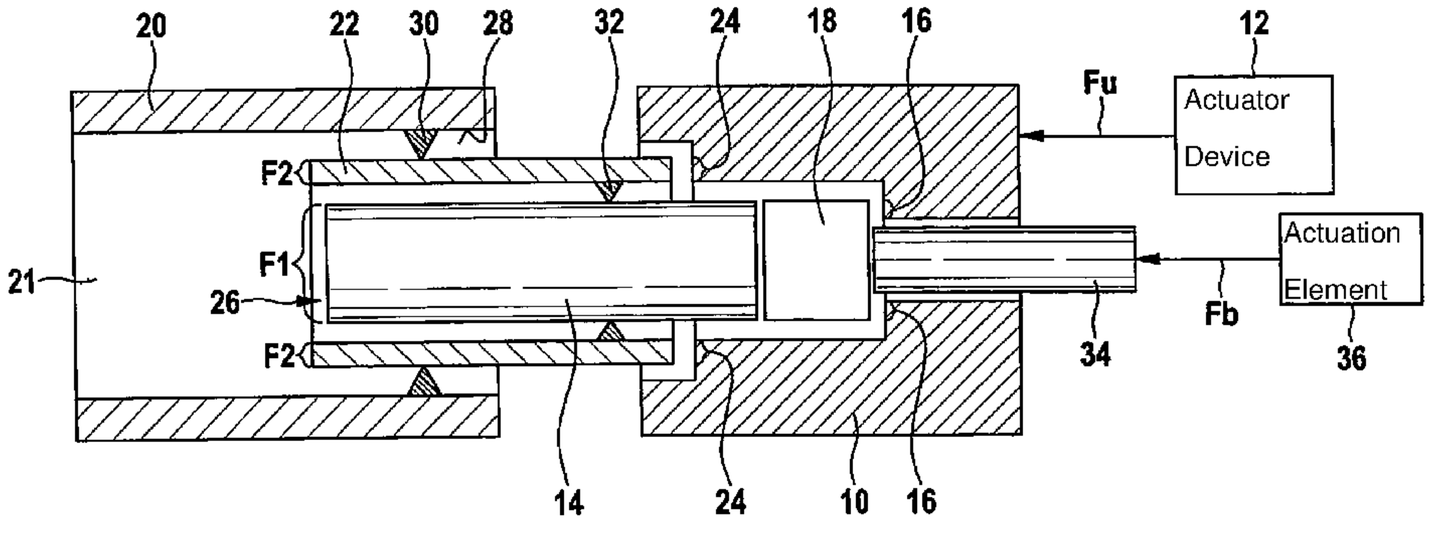
(57) **ABSTRACT**

A brake booster device for a braking system of a vehicle includes: a booster body to which a brake-boosting force is exertable by an actuator device; a first piston rod component to which the brake-boosting force is at least partially transmittable via a first contact with the booster body, the first piston rod component contacting the booster body at a first contact surface such that the first piston rod component is at least partially adjustable; and a second piston rod component to which the brake-boosting force is at least partially transmittable via a second contact with the booster body, the second piston rod component contacting the booster body at a second contact surface such that the second piston rod component is adjustable together with the first piston rod component.

15 Claims, 5 Drawing Sheets



(58) **Field of Classification Search**
USPC 29/888.02; 60/533, 547.1; 303/114.1
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,505,116	A *	3/1985	Weiler	B60T 11/203 60/547.1
8,459,753	B2 *	6/2013	Vollert	B60T 13/745 303/114.1
8,899,696	B2 *	12/2014	Weiberle	B60T 1/10 303/113.4
9,267,377	B2 *	2/2016	Weiberle	B60L 7/18
2009/0261649	A1 *	10/2009	Higuma	B60T 8/4275 303/113.3
2012/0192556	A1 *	8/2012	Verhagen	B60T 8/38 60/585
2015/0321651	A1 *	11/2015	Lhuillier	B60T 11/203 60/533

FOREIGN PATENT DOCUMENTS

DE	10 2009 047263		6/2010
EP	2 085 278		8/2009
JP	H06501220		2/1994
WO	2010069740	A1	6/2010
WO	2011012345	A1	2/2011

* cited by examiner

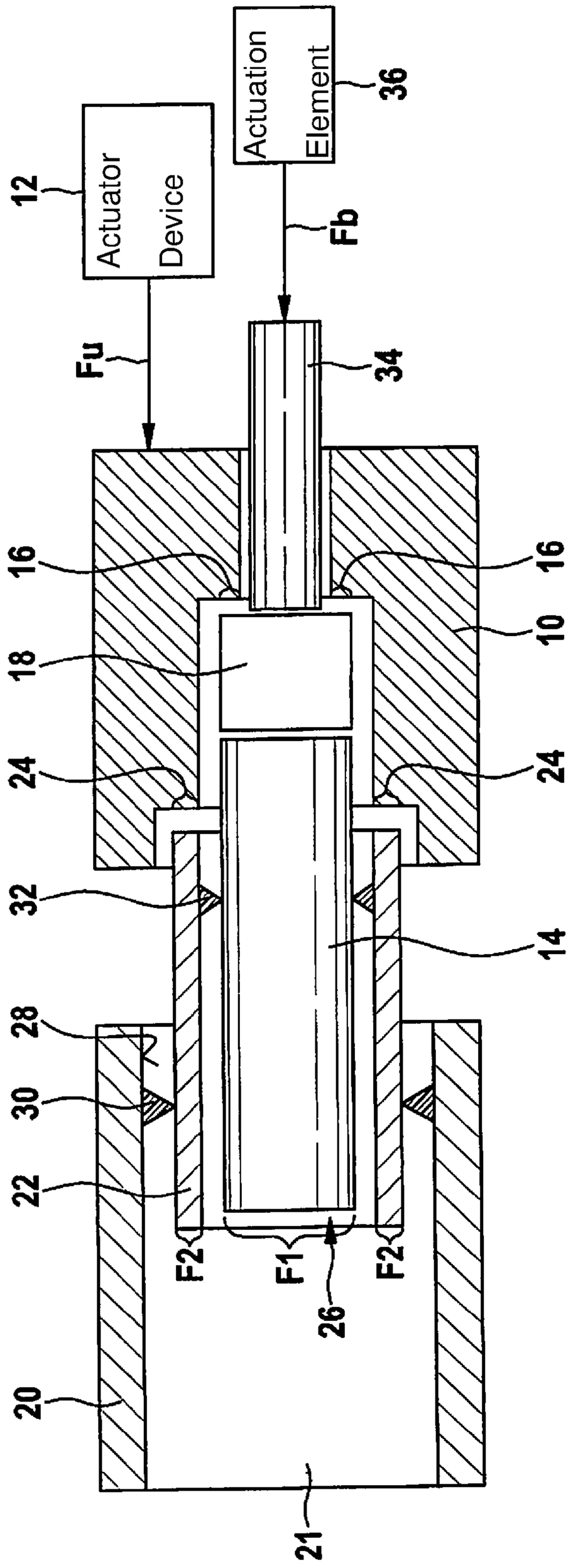

12
Actuator Device
Actuation Element
36
Fb
Fu
34
16
16
18
10
24
24
32
14
28
30
22
F2
F1
F2
26
20
21

Fig. 1

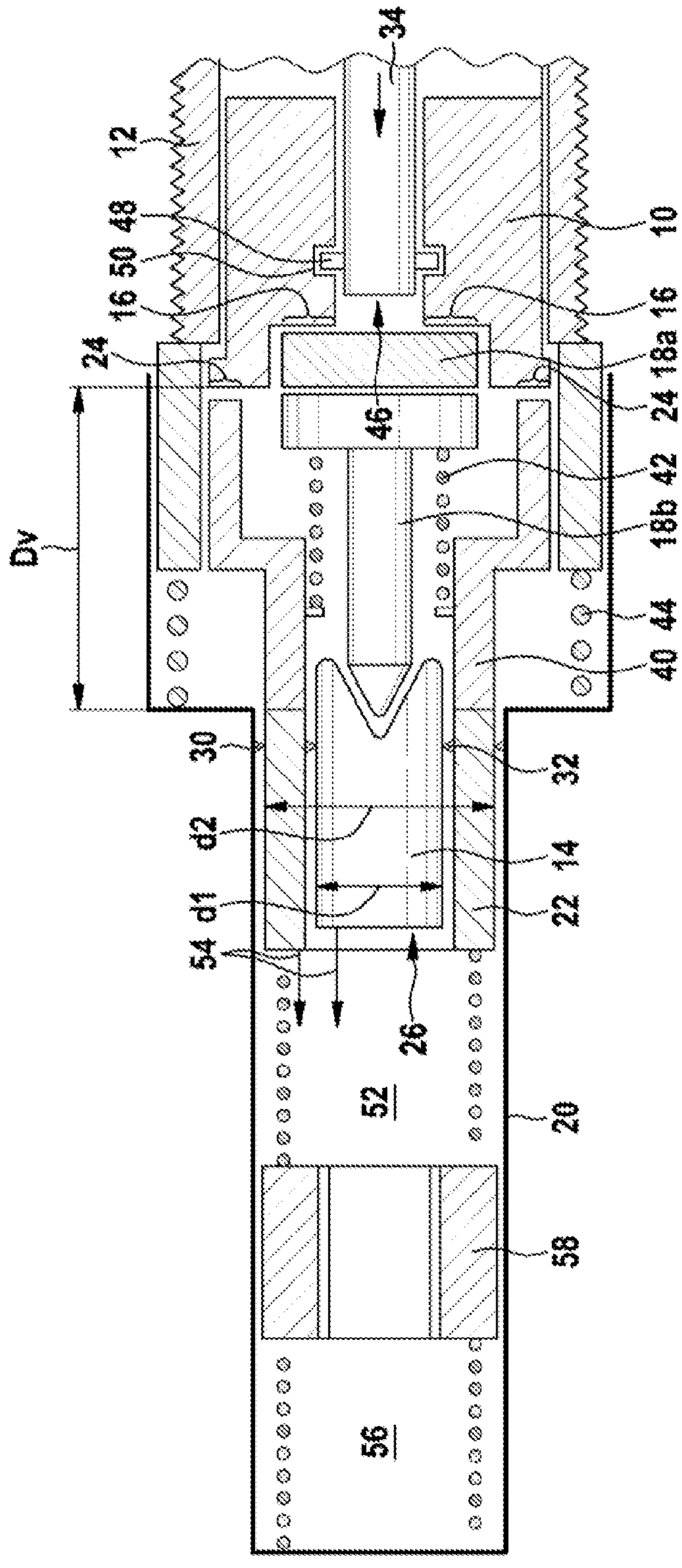

34
12
48
10
50
16
16
24
18a
24
46
42
Dv
18b
44
40
30
32
d2
14
d1
22
54
26
52
20
58
56

Fig. 2

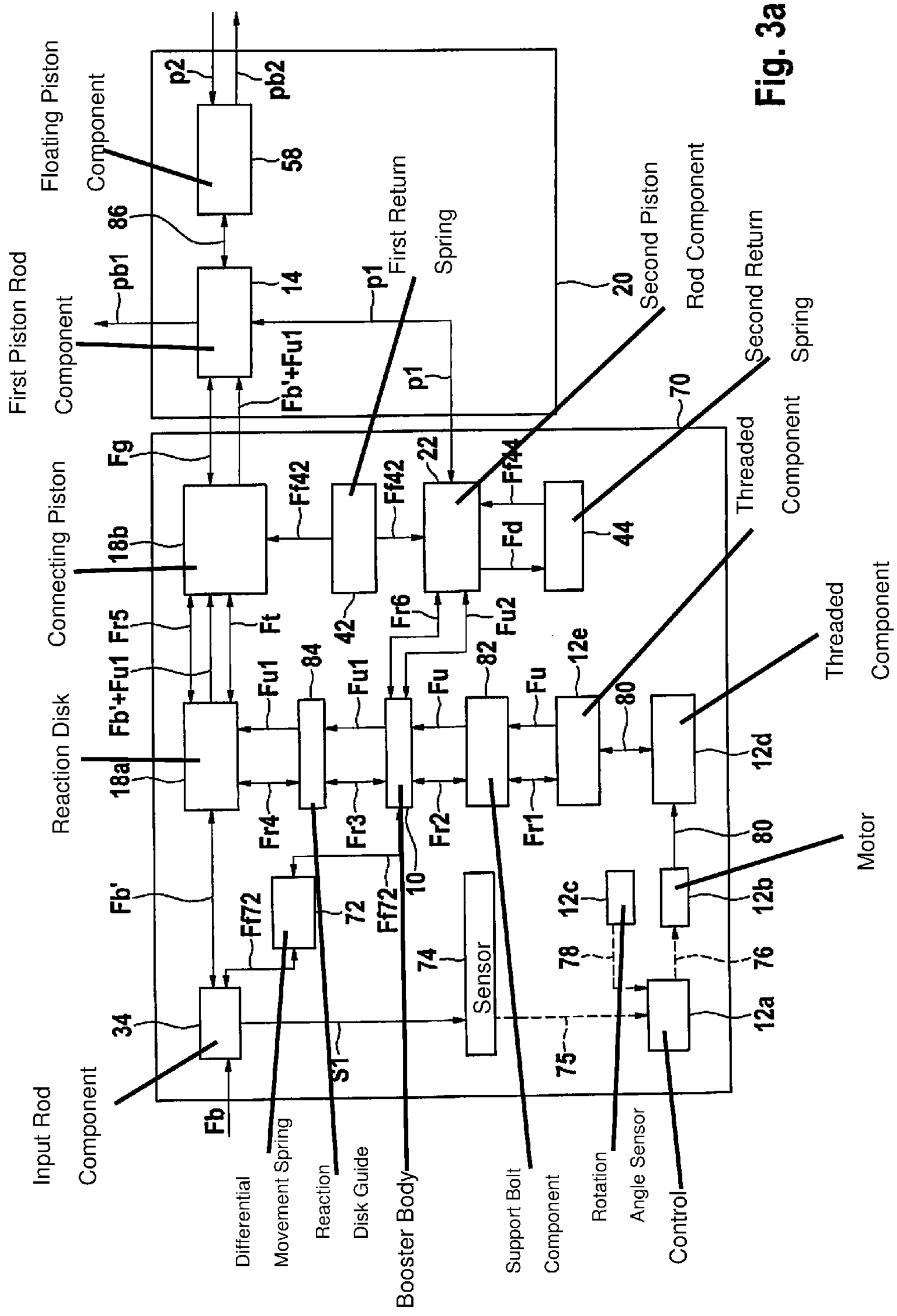

Input Rod Component
Differential
Movement Spring
Reaction Disk Guide
Booster Body
Support Bolt Component
Rotation Angle Sensor
Control Motor
Threaded Component
Second Return Spring
Rod Component
Second Piston
First Return Spring
First Piston Rod Component
Connecting Piston
Reaction Disk
Threaded Component
Fb
Fb'
Ff72
Fb'+Fu1
Fr5
Ft
Fu1
Fr4
Fr3
Fr2
Fr1
Fu
Fr6
Fu2
Ff42
Fg
Fd
Ff44
p2
pb2
pb1
p1
S1
Sensor
34
18a
18b
14
42
84
82
12e
80
12d
12c
12b
12a
10
72
74
75
78
76
86
58
20
22
44
70

Fig. 3a

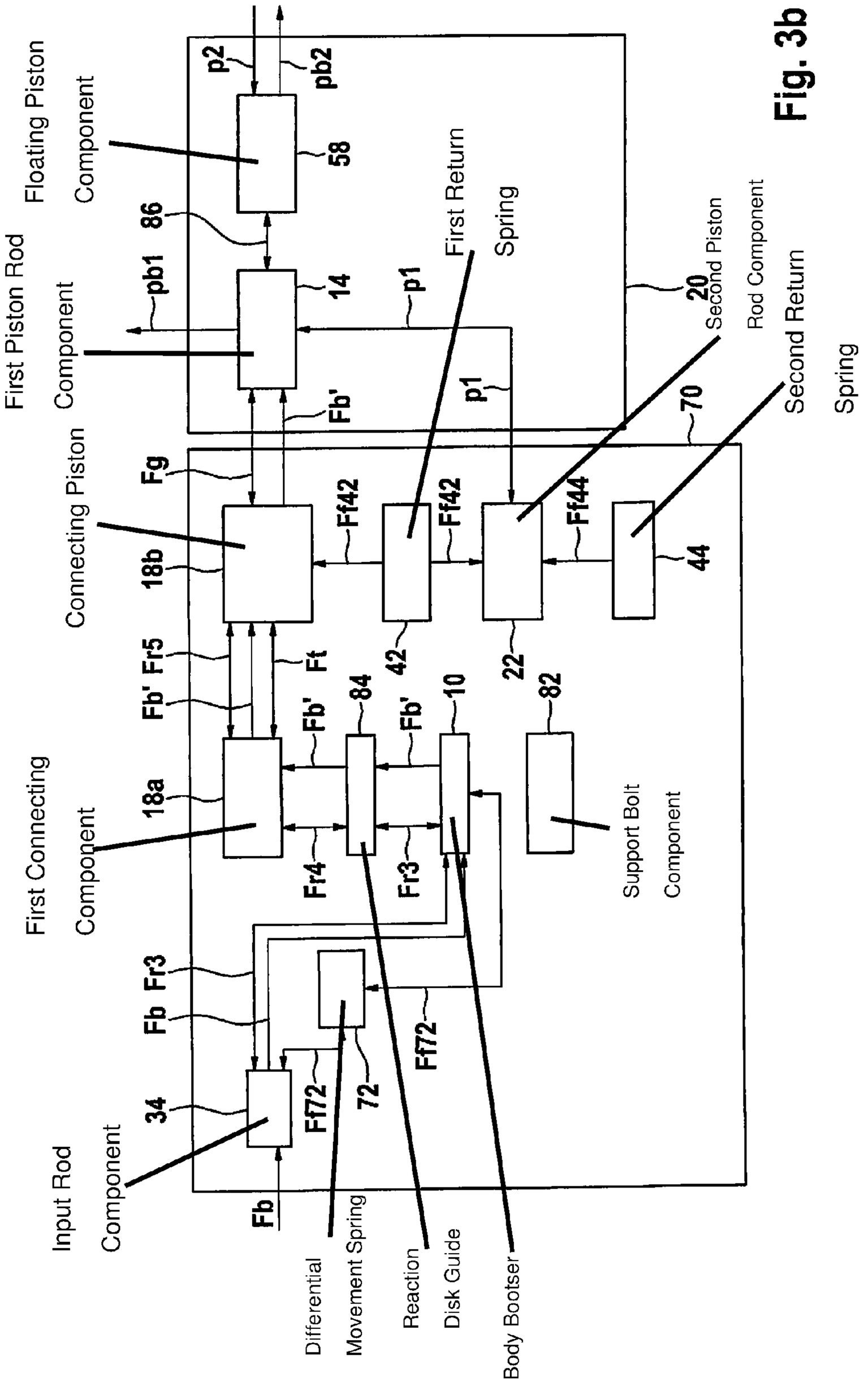

First Piston Rod Component
Floating Piston Component
Connecting Piston
First Connecting Component
Input Rod Component
Support Bolt
Second Piston Rod Component
First Return Spring
Second Return Spring
Differential
Movement Spring
Reaction Disk Guide
Body Bootser
p2
pb2
58
86
pb1
14
p1
Fb'
p1'
Fg
18b
Ff42
Ff42
Ff44
44
Fb' Fr5
Ft
42
22
Fb'
84
Fb'
10
82
18a
Fr4
Fr3
Fb Fr3
Fb
Ff72
72
Ff72
34
Fb
20
70

Fig. 3b

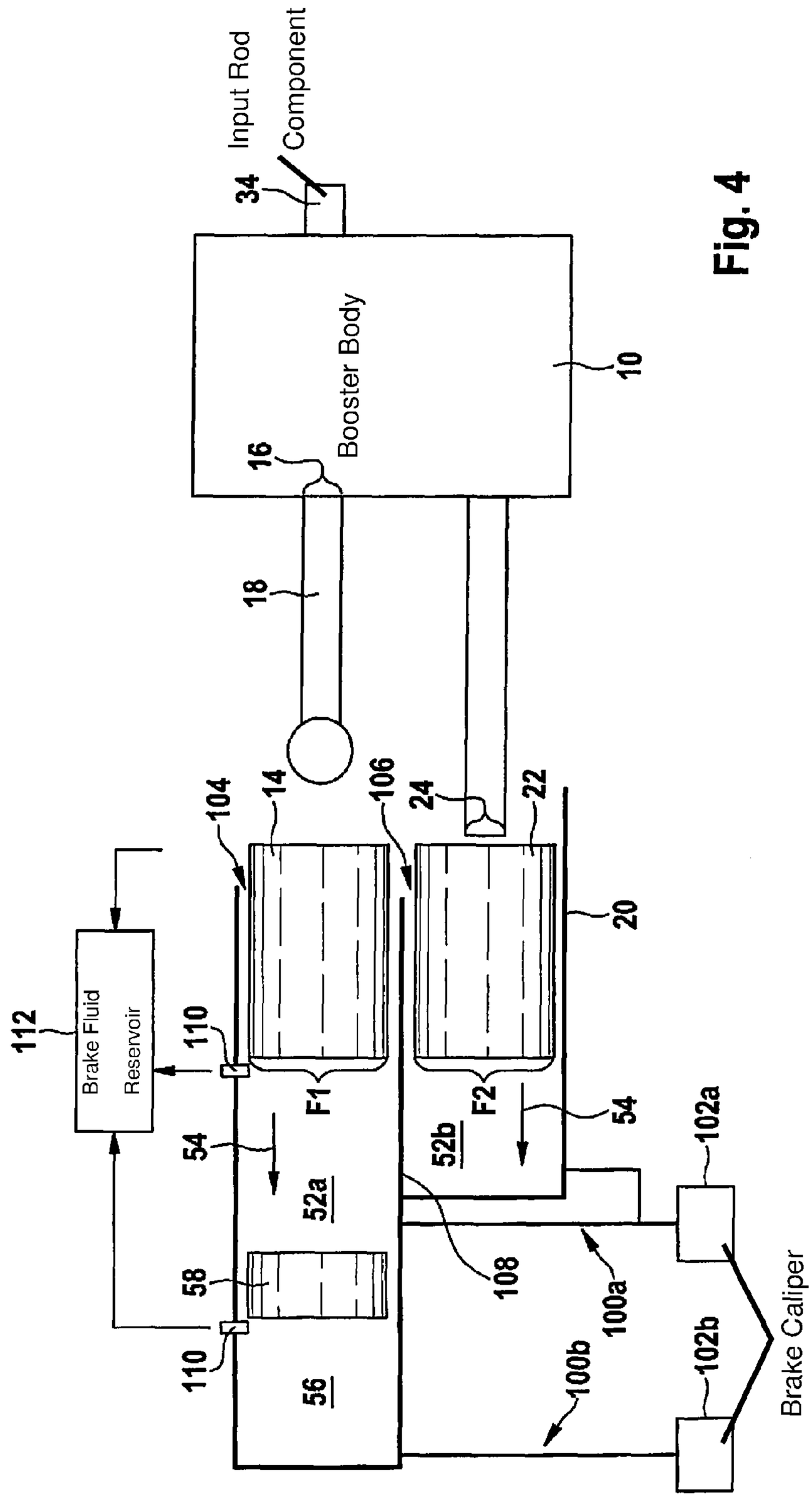

Input Rod
Component
34
Booster Body
16
10
18
104
14
106
24
22
20
112
Brake Fluid
Reservoir
110
F1
F2
54
52a
52b
58
56
108
100a
100b
102a
102b
Brake Caliper

Fig. 4

BRAKE BOOSTER DEVICE FOR A BRAKING SYSTEM OF A VEHICLE, AND METHOD FOR MANUFACTURING A BRAKE BOOSTER DEVICE FOR A BRAKING SYSTEM OF A VEHICLE

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a brake booster device for a braking system of a vehicle, a power booster for a braking system of a vehicle and a braking system for a vehicle, and a method for manufacturing a brake booster device for a braking system of a vehicle, a power booster of a braking system of a vehicle and a braking system of a vehicle.

2. Description of the Related Art

A brake booster is described in published German patent application document DE 10 2009 047 263 A1. The electromechanical brake booster may be used to exert a brake-boosting force on a booster body in such a way that through movement of the booster body, the brake-boosting force may be at least partially transmitted to an output element having a push rod in such a way that the push rod is insertable at least partially into a brake master cylinder

BRIEF SUMMARY OF THE INVENTION

The first piston rod component and/or the second piston rod component may be a piston rod. It is noted, however, that the first piston rod component and the second piston rod component are not limited to a design as a piston rod. In particular, the design of the first piston rod component and/or the second piston rod component is not limited to a particular type of piston rod.

Moreover, the first piston rod component and/or the second piston rod component may also be designed as contact part(s) for one piston rod respectively. In this case, the first piston rod component and/or the second piston rod component may be designed to each transmit a force independently of one another to a piston rod mounted or mountable thereon in such a way that the piston rod is adjustable with the aid of the transmitted force in such a way that the pressure volume of the brake master cylinder which may be filled with fluid is reducible.

The first piston rod component and/or the second piston rod component may be designed as a single piece/single part. Likewise, the first piston rod component and/or the second piston rod component may also be constructed of multiple subunits assembled together. The use of the term "component" does not limit the design of the first piston rod component and/or the second piston rod component to a single piece design.

The present invention implements a separation/subdivision of a piston rod component (primary piston) insertable into a pressure chamber of the brake master cylinder into different segments/pistons/bolt components. An incremental brake boosting is made possible with the aid of the implemented separation. In particular, the brake application surface leading into the brake master cylinder may be varied in this way.

In one advantageous specific embodiment, the brake booster device includes an input rod component on which a brake actuation element is mountable in such a way that a driver braking force exerted on the brake actuation element is transmittable to the input rod component. Preferably, the input rod component is at least temporarily in contact with the first piston rod component in such a way that the driver braking force is at least partially transmittable to the first piston rod component, while an at least partial transmission of the driver braking force to the second piston rod component is prevented. This configuration of the brake booster device has the advantage that during an operation the brake-boosting force may be applied in part directly for increasing the internal pressure present in the brake master cylinder to the second piston rod component, while a part of the brake-boosting force is exerted on the first piston rod component for the purpose of boosting the brake actuation by the driver.

Preferably, when an actuator device is present in the deactivated state, the first piston rod component is adjustable with the aid of the driver braking force to which the latter is at least partially transmitted. In the event the actuator device is functionally impaired, such as, for example, if the actuator device malfunctions, a hydraulic transmission is then activated which, when a driver braking force is applied by the driver, results in a greater increase in the internal pressure in the brake master cylinder, as compared to the related art. This may also be described as the brake booster device still being usable as a volume booster in the event the actuator device becomes functionally impaired.

For example, the second piston rod component may have a continuous recess, the first piston rod component being positioned for adjustable movement at least partially within the continuous recess. Thus, the two piston rod components may be inserted in a simple manner through an opening of the brake master cylinder.

As an alternative, the first piston rod component is insertable in an adjustment direction through a first opening of a brake master cylinder, the second piston rod component being movable in the adjustment direction through a second opening of the brake master cylinder. As explained in greater detail below, such an assembly and configuration of the two piston rod components allows for an advantageous design of the brake master cylinder.

The aforementioned advantages are ensured in a power booster for a braking system of a vehicle which has such a brake booster device and a brake master cylinder.

In one advantageous specific embodiment, the first piston rod component and the second piston rod component may protrude into a first pressure chamber of the brake master cylinder in such a way that a first residual volume of the first pressure chamber fillable with a fluid is variable with the aid of an adjustment of the first piston rod component and/or the second piston rod component, the brake master cylinder including a second pressure chamber into which a floating piston component protrudes in such a way that a second residual volume of the second pressure chamber fillable with a fluid is variable with the aid of an adjustment of the floating piston component. Thus, the advantageous power booster may also be equipped with a tandem brake master cylinder. The advantageous power booster is therefore useful for a number of different brake circuit designs.

Alternatively or in addition, the first piston rod component may protrude into a first partial pressure chamber of the brake master cylinder in such a way that a partial residual volume of the first partial pressure chamber fillable with a fluid is variable with the aid of an adjustment of the first piston rod component, the second piston rod component protruding into a second partial pressure chamber of the brake master cylinder, which is separated from the first partial pressure chamber by a continuous or discontinuous partition in such a way that a second partial residual volume of the second partial pressure chamber fillable with a fluid is variable with the aid of an adjustment of the second piston

rod component. Such a configuration of the brake master cylinder allows for greater freedom of design.

The advantages described above are also achieved in a corresponding braking system having at least one brake circuit and one brake booster device and one brake master cylinder, and one corresponding power booster.

In addition, the advantages are also implemented in a corresponding method for manufacturing a brake booster device for a braking system of a vehicle.

The advantages also result from carrying out a method for manufacturing a power booster of a braking system of a vehicle.

Furthermore, the advantages are implementable by carrying out a corresponding method for manufacturing a braking system of a vehicle.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** shows a schematic representation of one first specific embodiment of the brake booster device.

FIG. **2** shows a schematic representation of one second specific embodiment of the brake booster device.

FIGS. **3***a* and **3***b* show functional diagrams to represent one third specific embodiment of the brake booster device.

FIG. **4** shows a schematic representation of one specific embodiment of the power booster.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** shows a schematic representation of one first specific embodiment of the brake booster device.

The brake booster device schematically illustrated in FIG. **1** is usable in a (hydraulic) braking system of a vehicle. The brake booster device includes a booster body **10**, to which a brake-boosting force Fu is exertable with the aid of an actuator device **12** in such a way that booster body **10** is adjustable with the aid of brake-boosting force Fu. Booster body **10** may be designed as a valve body, for example. However, the design of booster body **10** is relatively freely variable for an advantageous interaction with actuator device **12**. Actuator device **12** may, for example, be an electromechanical device or a hydraulic device. The design of actuator device **12** is not limited to these cited examples, however.

The brake booster device also includes one first piston rod component **14**. First piston rod component **14** is positioned relative to booster body **10** in such a way that brake-boosting force Fu is at least partially transmittable to first piston rod component **14**. Brake-boosting force Fu may be transmitted, for example, via a first force-transmitting contact between first piston rod component **14** contacting a first contact surface of the booster body and booster body **10**. Alternatively, the first force-transmitting contact for at least partially transmitting brake-boosting force Fu may also take place by way of one first connecting component **18** which contacts first piston rod component **14** and first contact surface **16** of booster body **10**. First connecting component **18** may, for example, be a reaction disk. The design of first connecting component **18** is not limited to a reaction disk, however.

The at least partial transmission of brake-boosting force Fu via the first force-transmitting contact may be carried out in such a way that first piston rod component **14** is adjustable. In particular, if first piston rod component **14** is positioned on a brake master cylinder **20**, a volume in brake master cylinder **20** fillable with a fluid is reducible (in size) with the aid of the at least partial transmission of brake-boosting force Fu for the purpose of adjusting first piston rod component **14**.

The brake booster device further includes one second piston rod component **22**, to which brake-boosting force Fu is at least partially transmittable via one second force-transmitting contact in such a way that second piston rod component **22** is adjustable together with first piston rod component **14**. A volume in brake master cylinder **20** fillable with a fluid is also reducible (in size) with the aid of the at least partial transmission of brake-boosting force Fu for the purpose of adjusting second piston rod component **22**. The second force-transmission contact may take place between second piston rod component **22** contacting a second contact surface **24** of booster body **10** and booster body **10**. Alternatively, the second force-transmission contact may also take place between second piston rod component **22** and booster body **10** via a second connecting component (not delineated) which contacts second contact surface **24** of booster body **10**.

In one advantageous specific embodiment, first piston rod component **14** and/or second piston rod component **22** may be designed as piston rods. In particular, first piston rod component **14** and second piston rod component **22** may be positioned or is/are positionable on brake master cylinder **20** in such a way that first piston rod component **14** and second piston rod component **22** delimit a variable (in terms of size) pressure chamber **21** of brake master cylinder **20**. Hence, first piston rod component **14** and/or second piston rod component **22** may be designated as brake master cylinder-primary piston and/or brake master cylinder-piston rod/partial piston rod. The feasibility of piston rod components **14** and **22** is not limited to a particular rod or piston shape, however.

It is noted that first piston rod component **14** and second piston rod component **22** are not restricted to a design as piston rods. Instead, first piston rod component **14** and/or second piston rod component **22** may also be designed as contact parts, one for each piston rod. In such a case, first piston rod component **14** and/or second piston rod component **22** may also be designed to transmit each independently of one another a force to one piston rod each positioned or positionable thereon in such a way that the piston rod is adjustable with the aid of the transmitted force in such a way that a pressure volume of brake master cylinder **20** fillable with fluid is reducible.

First piston rod component **14** and/or second piston rod component **22** may be designed as a single piece/single part. Likewise, first piston rod component **14** and/or second piston rod component **22** may be constructed of multiple assembled subunits.

First contact surface **16** may also be understood to mean multiple partial surfaces separated from one another. Accordingly, second contact surface **24** may also be subdivided into multiple partial surfaces separated from one another. (The term "contact surface" is used in the singular merely for the sake of clarity.) It is noted, however, that first contact surface **16** and second contact surface **24** are understood to mean different (overall) surfaces. This may also be described as two contact surfaces **16** and **24** at most touching, but not overlapping one another. Likewise, contact surfaces **16** and **24** are not meant to be understood as congruent surfaces.

First piston rod component **14** is preferably adjustable without a corresponding movement by second piston rod component **22**. The advantageous adjustability of first piston rod component **14** may be independent of a position of

second piston rod component **22**. Likewise, second piston rod component **22** may also be adjustable without a corresponding movement of first piston rod component **14** and/or independently of a position of first piston rod component **14**.

Thus, the brake booster device schematically illustrated in FIG. **1** implements a brake booster which acts on two piston rod components **14** and **22** which are adjustable independently of one another. In this configuration, first piston rod component **14** may be associated with a first boundary surface F**1**, along which an adjustment of first piston rod component **14** causes a variation in volume of variable (in terms of its size) pressure chamber **21** of brake master cylinder **20**. This may also be described as a force which is transmitted to first piston rod component **14** opposing the pressure in pressure chamber **21** of brake master cylinder **20** at first boundary surface F**1**. Likewise, second piston rod component **22** may also be associated with a second boundary surface F**2**, at which surface braking into pressure chamber **21** of brake master cylinder **20** may occur with the aid of the force transmitted to second piston rod component **22**. Hence, the independent adjustability of piston rod components **14** and **22** causes a variability of the brake application surface into pressure chamber **21** of brake master cylinder **20**. The resulting advantages are discussed in greater detail below.

In the specific embodiment shown, second piston rod component **22** has a continuous recess **26** into which the first piston rod component at least partially protrudes. First piston rod component **14** is adjustably situated within continuous recess **26**. Additional positioning options for the two piston rod components **14** and **22** are described in greater detail below.

The two piston rod components **14** and **22** protrude into an opening of brake master cylinder **20**. To prevent seepage of brake fluid along an opening edge **28** of the opening, a sealing element **30**, such as a sealing ring, may be positioned between opening edge **28** and second piston rod component **22**. Likewise, seepage of fluid through continuous recess **26** is preventable by positioning a second sealing element **32**, such as a sealing ring, within continuous recess **26** between second piston rod component **22** and first piston rod component **14**.

In one advantageous specific embodiment, the brake booster device includes an input rod component **34** on which a brake actuation element **36** is mountable in such a way that a driver braking force Fb exerted on brake actuation element **36** is transmittable to input rod component **34**. Mountable brake actuation device **36** may be a brake pedal, for example. Instead of a brake pedal, a differently designed brake actuation element **36** may also be mounted on input rod component **34**.

Input rod component **34** is preferably at least temporarily in (force transmitting) contact with first piston rod component **14** in such a way that driver braking force Fb is transmittable at least partially to first piston rod component **14**, while an at least partial transmission of driver braking force Fb to second piston rod component **22** is prevented. Prevention of at least a partial transmission of driver braking force Fb to second piston rod component **22** is not to be understood as an active process. Instead, input rod component **34** may at least temporarily contact first piston rod component **14** in such a way that no driver braking force Fb is transmitted to second piston rod component **22**.

In the brake booster device schematically illustrated in FIG. **1**, first piston rod component **14** is movable by driver braking force Fb (assisted by actuator device **12**). Conversely, second piston rod component **22** is movable with the aid of actuator device **12** with no exertion of force by the driver.

In particular, when actuator device **12** is present in a deactivated state, first piston rod component **14** may be at least partially moved into the brake master cylinder with the aid of the at least partially previously transmitted driver braking force Fb. The advantageously split design of the piston rod in this case has the advantage that in the event actuator device **12** becomes functionally impaired, only first piston rod component **14** is movable with the aid of an actuation of brake actuation element **36**, while second piston rod component **22** remains in a certain position in spite of the actuation of brake actuation element **36** by the driver. Hence, the driver is not required to brake into pressure chamber **21** of brake master cylinder **20** using the entire brake application surface equal to the sum of the boundary surfaces F**1**+F**2**, but merely a reduced brake application surface equal to first boundary surface F**1**. In this way, a stronger braking effect is created with the aid of a changed hydraulic transmission even though driver braking force Fb remains the same. This may also be described as driver braking force Fb causing a greater pressure buildup in brake master cylinder **20** as a result of the reduced brake application surface equal to first boundary surface F**1**.

FIG. **2** shows a schematic representation of one second specific embodiment of the brake booster device.

The brake booster device schematically shown in FIG. **2** includes the components previously described above. As is apparent from FIG. **2**, first connecting component **18***a* and **18***b* may also be designed in multiple parts. In particular, first connecting component **18***a* and **18***b* includes a reaction disk **18***a* and a connecting piston **18***b*. In addition to first connecting component **18***a* and **18***b*, a second (single piece or multi-piece) connecting component **40** may also be positioned between second piston rod component **22** and booster body **10**, by way of which the second force transmission contact is ensured, second connecting component **40** contacting second contact surface **24** of booster body **10**. To ensure a reliable resetting of first connecting component **18***a* and **18***b* and/or second connecting component **40** in a starting position when the brake actuation element (not delineated) is not actuated, a first return spring **42** may be associated with first connecting component **18***a* and **18***b* and a second return spring **44** may be associated with second connecting component **40**.

Input rod component **34** may by guided through a central bore of booster body **10**. Seepage of fluid may be prevented with the aid of a sealing element **48**, such as a sealing ring, situated in center bore **46**. In particular, a sealing element **48** in the form of a sealing ring may be fixed in a simple manner in a preferred operating position with the aid of a groove **50** formed in booster body **10** or in input rod component **34**.

In the specific embodiment shown, the brake booster device is mounted on a brake master cylinder **20** designed as a tandem brake master cylinder. In addition to a first pressure chamber **52** into which first piston rod component **14** and second piston rod component **22** may be at least partially moved, each in a common adjustment direction **54**, the brake master cylinder so designed also includes a second pressure chamber **56**. A floating piston component **58** is insertable at least partially into second pressure chamber **56**. It is noted that neither first piston rod component **14** nor second piston rod component **22** is understood to mean a floating piston component **58**.

Instead, the two piston rod components **14** and **22** are designed to jointly control a first internal pressure in first

pressure chamber **52**, while a second internal pressure may be adjusted/fixed in second pressure chamber **56** with the aid of floating piston component **58**.

Thus, the advantageously designed brake booster device may also be used together with a brake master cylinder **20** designed as a tandem brake master cylinder. It is noted, however, that the advantageous brake booster device may also be used with a brake master cylinder **20** having just one pressure chamber **52**, into which the two piston rod components **14** and **22** are insertable.

First piston rod component **14** may have a diameter d**1** which, for example, is equal to half of a second diameter d**2** of second piston rod component **22**. In this case, a comparatively high translation of driver braking force Fb into a pressure increase is ensured, even given a functional impairment of the actuator device in which internal pressure in brake master cylinder **20** may only be increased via driver braking force Fb. However, the dimensions of piston rod components **14** and **22** are not limited to the exemplary diameters d**1** and d**2** reproduced herein. (Even the lengthening diameter Dv delineated in FIG. **2** is to be interpreted as solely exemplary.)

FIGS. **3***a* and **3***b* show functional diagrams for representing one third specific embodiment of the brake booster device.

Brake booster device **70** schematically illustrated in FIGS. **3***a* and **3***b* is shown in different functional states. FIG. **3***a* illustrates the functionality of brake booster device **70** in which the applicability of brake booster actuators is ensured. In contrast, FIG. **3***b* shows the functionality of brake booster device **70** in the event of a functional impairment, such as a failure, of the brake booster actuators.

An input rod component **34** is adjustable with the aid of a driver braking force Fb, both when the functionality of the brake booster actuators is ensured as well as when the brake booster actuators are functionally impaired. In such a case, at least a part Fb' of driver braking force Fb is transmitted to a reaction disk **18***a*. A differential-movement spring **72** which is situated between input rod component **34** and booster body **10** of brake booster device **70** may be compressed against a spring force Ff**72**.

In the function mode illustrated in FIG. **3***a* in which the functionality of the brake booster actuators is ensured, the actuation of input rod component **34** is also ascertainable with the aid of a sensor **74**, such as a braking force sensor. For example, sensor **74** ascertains a sensor value S**1** corresponding to driver braking force Fb. Sensor **74** then outputs a control signal **76** corresponding to sensor value S**1** to a control **12***a* of an actuator device. Control **12***a* of the actuator device may be designed to provide a voltage signal **76** corresponding to sensor signal **75** to a motor **12***b* of the actuator device. Optionally, control **12***a* is also designed, when providing voltage signal **76** to motor **12***b*, to take into account a rotation angle signal **78** of a rotation angle sensor **12***c* of the actuator device mounted on motor **12***b*.

Motor **12***b* activated by control **12***a* exerts a torque **80** on threaded components **12***d* and **12***e* of the actuator device. By actuating threaded components **12***d* and **12***e* of the actuator device, at least one brake-boosting force Fu is transmittable to a support bolt component **82**. In this case, the support bolt component **82** is adjusted counter to a friction force Fr**1** in such a way that brake-boosting force Fu is transmitted to booster body **10** and booster body **10** is adjusted counter to a friction force Fr**2** with the aid of brake-boosting force Fu.

A first contact surface of booster body **10** contacts a reaction disk guide **84** in such a way that reaction disk guide **84** is adjusted counter to a friction force Fr**3** by at least the first partial brake-boosting force Fu**1** transmitted thereto. By adjusting reaction disk guide **84**, first partial brake-boosting force Fu**1** is transmitted to reaction disk **18***a* previously cited above. In such a case, the reaction disk may be deformed against an elastic force Fr**4**. At the same time, when the braking actuation element is actuated while the actuator device is in a functionally ensured state, reaction disk **18***a* transmits the sum of the at least partially transmitted driver braking force Fb' and the first partial brake-boosting force Fu**1** (total force Fb'+Fu**1**) to the above cited connecting element **18***b* and further to a first piston rod component **14**. (The adjustment movement of connecting element **18***b*, with the aid of the total force Fb'+Fu**1** transmitted thereto, may counteract an inertial force Ft and/or a friction force Fr**5**).

First piston rod component **14** may be at least partially moved into a first pressure chamber of brake master cylinder **20** with the aid of the total transmitted force Fb'+Fu**1**. Counteracting the movement of first piston rod component **14** into the first pressure chamber is a first pressure p**1** prevailing therein, or a corresponding force Fg counter to first pressure p**1**. As a result of the movement of first piston rod component **14** into the first pressure chamber of brake master cylinder **20**, first pressure P**1** is increased, and thus a first braking pressure pb**1** is built up in at least one first brake caliper hydraulically connected to the first pressure chamber.

Moreover, first piston rod component **14** may be connected to a floating piston **58** via a connecting component **86** in such a way that as first piston rod component **14** is moved into the first pressure chamber, floating piston **58** may be at least partially moved into a second pressure chamber. Counteracting the movement of floating piston **58** into the second pressure chamber is a second pressure p**2**. With the aid of the movement of floating piston **58** into the second pressure chamber, pressure p**2** may be increased in such a way that a second braking pressure pb**2** may be built up in at least one second brake caliper hydraulically connected to the second pressure chamber.

Booster body **10** also contacts a second piston rod component **22** in such a way that a second partial braking assist force Fu**2** is transmittable to second piston rod component **22** and second piston rod component **22** is insertable against spring forces Ff**42** and Ff**44** of previously described springs **42** and **44** into the first pressure chamber of brake master cylinder **20**. (Here, spring **44** in particular may be easily compressed by a deformation force Fd). With the movement of second piston rod component **22** into the first pressure chamber of brake master cylinder **20**, first pressure p**1** prevailing therein may be further increased so that first braking pressure pb**1** transmitted to the at least one first brake caliper may also be increased by second partial braking assist force Fu**2**. Likewise, second pressure p**2** and second braking pressure pb**2** may also be increased by the additional pressure build-up in the first pressure chamber of brake master cylinder **20**.

FIG. **3***b* shows the functional diagram for the actuator device when it is in a functionally impaired state. In this state, no braking assist force Fu may be exerted on booster body **10** with the aid of the actuator device. However, the first piston rod component may still be adjusted with the aid of the driver braking force Fb to which the latter is at least partially applied. While the second piston rod component remains in a constant position, first pressure p**1** prevailing in the first pressure chamber may still be increased with the aid of the adjustment of first piston rod component **14** and second pressure p**2** prevailing in the second pressure chamber may still be increased via the connecting component. Instead of a braking into the first pressure chamber at the

boundary surfaces of both piston rod components **14** and **22**, braking into the first pressure chamber occurs solely with the boundary surface of first piston rod component **14**.

The reduced brake application surface resulting from the actuator device being present in a functionally impaired state may produce an improved force to pressure translation ratio. Because of the comparatively high force to pressure translation ratio achievable, the driver is able, with the aid of driver braking force Fb, to effect a comparatively high first pressure p**1** in the first pressure chamber of brake master cylinder **20** and, by association, to also effect a comparatively high first braking pressure pb**1** in the at least one first brake caliper. Likewise, due to the advantageous force to pressure translation ratio, a comparatively high second pressure p**2** and a comparatively high second braking pressure pb**2** may also be implemented with the aid of driver braking force Fb.

FIG. **4** shows a schematic representation of one specific embodiment of the power booster.

The power booster schematically illustrated in FIG. **4** includes a brake booster device and a brake master cylinder **20**. The power booster may be used in a braking system having at least one brake circuit **100***a* and **100***b*, each including at least one brake caliper **102***a* and **102***b*. Since, however, the usability of the power booster is not limited to a specific design of the at least one brake circuit **100***a* and **100***b*, the individual components of the at last one brake circuit **100***a* and **100***b* are not further discussed.

In the specific embodiment shown, first piston rod component **14** is adjustable in an adjustment direction **54** through a first opening **104** of brake master cylinder **20**, while second piston rod component **22** is adjustable in adjustment direction **54** through an opening **106** of brake master cylinder **20**. This may also be described as first piston rod component **14** protruding into a first partial pressure chamber **52***a* of brake master cylinder **20** so that a first partial residual volume of first partial pressure chamber **52***a* fillable with a fluid is variable with the aid of an adjustment of first piston rod component **14**, while second piston rod component **22** protrudes into a second partial pressure chamber **52***b* of brake master cylinder **20** in such a way that a second partial residual volume of second partial pressure chamber **52***b* fillable with a fluid is variable with the aid of an adjustment of second piston rod component **22**. Formed between first partial pressure chamber **52***a* and second partial pressure chamber **52***b* is a continuous or discontinuous partition **108**.

The two partial pressure chambers **52***a* and **52***b* may be considered as subunits of a common pressure chamber, provided an exchange of fluid between both partial pressure chambers **52***a* and **52***b* is ensured. In this case, a common first pressure is adjustable in both partial pressure chambers **52***a* and **52***b*. Thus it is also sufficient to connect just one of the two partial pressure chambers **52***a* and **52***b* to a brake fluid reservoir **112** via an orifice bore **110**.

The exchange of fluid between the two partial pressure chambers **52***a* and **52***b* may be ensured, for example, by the formation of at least one flow-through opening in discontinuous partition **108**. In a continuous partition **108** it is also possible for both partial pressure chambers **52***a* and **52***b* to be tied/connected to one common first brake circuit **100***a*. In this case, the exchange of fluid between the two partial pressure chambers **52***a* and **52***b* is possible, provided neither of the two partial pressure chambers **52***a* and **52***b* are decoupled from first brake circuit **100***a* by the closing of a cut-off valve.

In the specific embodiment shown, brake master cylinder **20** is designed as a tandem brake master cylinder which, in addition to first partial pressure chamber **52***a* and second partial pressure chamber **52***b*, together forming a first pressure chamber, also includes a second pressure chamber **56**. It is noted, however, that the design of brake master cylinder **20** described herein as a tandem brake master cylinder is purely optional. Moreover, input rod component **34** may also be used as first connecting component **18**.

The specific embodiments of the brake booster device and of the power booster described above may be easily designed using a selection of dimensions of their components in such a way that even at a driver braking force of 500N, a vehicle deceleration of 2.44 m/s^2 is achievable, even if the actuator device is functionally significantly impaired, as a result of which no brake-boosting force may be supplied. In all specific embodiments relatively high decelerations may be achieved in the event of failure of the actuator device. In addition, in all specific embodiments brake master cylinder **20** may be designed without regard to the deceleration achievable in the event of failure of the actuator device.

A further advantage of the above-described specific embodiments of the brake booster device and the power booster is that prompting the brake system to meet additional demands, such as generating a vehicle deceleration of 6.44 m/s^2 at a driver braking force of 500N, may be accomplished even when an ignition key has been removed. Moreover, the above described technology may be used to manufacture brake booster devices of reduced complexity.

The advantageous manufacturing methods are schematically illustrated with reference to the specific embodiments of the brake booster device and power booster described above. Thus, no additional description of the manufacturing methods is provided.

What is claimed is:

1. A brake booster device for a braking system of a vehicle, comprising:

a booster body to which a brake-boosting force is exerted with the aid of an actuator device in such a way that the booster body is adjusted with the aid of the brake-boosting force;

a first piston rod component to which the brake-boosting force is at least partially transmitted via one of (i) a first force-transmitting contact between the first piston rod component which contacts the booster body at a first contact surface or (ii) a first connecting component which contacts the first piston rod component and the first contact surface of the booster body, in such a way that the first piston rod component is at least partially adjusted;

a second piston rod component to which the brake-boosting force is at least partially transmitted via one of (iii) a second force-transmitting contact between the second piston rod component which contacts the booster body at a second contact surface and the booster body or (iv) a second connecting component which contacts the second piston rod component and the second contact surface of the booster body, in such a way that the second piston rod component is adjusted together with the first piston rod component; and

an input rod component on which a brake actuation element is mounted, wherein a driver braking force exerted on the brake actuation element bypasses the booster body and is transmitted to the input rod component, wherein:

the driver braking force is applied to the first piston rod component via the input rod component while the input rod component bypasses the booster body.

2. The brake booster device as recited in claim **1**, wherein the input rod component is at least temporarily in contact with the first piston rod component in such a way that the driver braking force is at least partially transmitted to the first piston rod component, while at least partial transmission of the driver braking force to the second piston rod component is prevented.

3. The brake booster device as recited in claim **2**, wherein the first piston rod component is adjusted with the aid of the driver braking force transmitted at least temporarily to the first piston rod component when the actuator device is present in a deactivated state.

4. The brake booster device as recited in claim **2**, wherein the second piston rod component includes a continuous recess, and the first piston rod component is adjustably situated at least partially within the continuous recess.

5. The brake booster device as recited in claim **2**, wherein the first piston rod component is adjusted in an adjustment direction through a first opening of a brake master cylinder, and the second piston rod component is adjustable in an adjustment direction through a second opening of the brake master cylinder.

6. A power booster for a braking system of a vehicle, comprising:

a brake master cylinder; and

a brake booster device having:

a booster body to which a brake-boosting force is exerted with the aid of an actuator device in such a way that the booster body is adjusted with the aid of the brake-boosting force;

a first piston rod component to which the brake-boosting force is at least partially transmitted via one of (i) a first force-transmitting contact between the first piston rod component which contacts the booster body at a first contact surface or (ii) a first connecting component which contacts the first piston rod component and the first contact surface of the booster body, in such a way that the first piston rod component is at least partially adjusted;

a second piston rod component to which the brake-boosting force is at least partially transmitted via one of (iii) a second force-transmitting contact between the second piston rod component which contacts the booster body at a second contact surface and the booster body or (iv) a second connecting component which contacts the second piston rod component and the second contact surface of the booster body, in such a way that the second piston rod component is adjusted together with the first piston rod component; and

an input rod component on which a brake actuation element is mounted, wherein a driver braking force exerted on the brake actuation element bypasses the booster body and is transmitted to the input rod component, wherein:

the driver braking force is applied to the first piston rod component via the input rod component while the input rod component bypasses the booster body.

7. The power booster as recited in claim **6**, wherein:

the first piston rod component and the second piston rod component protrude into a first pressure chamber of the brake master cylinder in such a way that a residual volume of the first pressure chamber for filling with a fluid is variable with the aid of an adjustment of at least one of the first piston rod component and the second piston rod component; and

the brake master cylinder includes a second pressure chamber into which a floating piston component protrudes in such a way that a second residual volume of the second pressure chamber for filling with a fluid is variable with the aid of an adjustment of the floating piston component.

8. The power booster as recited in claim **6**, wherein:

the first piston rod component protrudes into a first partial pressure chamber of the brake master cylinder in such a way that a partial residual volume of the first partial pressure chamber for filling with a fluid is variable with the aid of an adjustment of the first piston rod component; and

the second piston rod component protrudes into a second partial pressure chamber of the brake master cylinder, which is separated from the first partial pressure chamber by a partition, in such a way that a second partial residual volume of the second partial pressure chamber for filling with a fluid is variable with the aid of an adjustment of the second piston rod component.

9. The power booster as recited in claim **6**, wherein the braking system includes at least one brake.

10. A method for manufacturing a brake booster device for a braking system of a vehicle, comprising:

mounting a booster body in such a way that during an operation of the brake booster device with the aid of an actuator device a brake-boosting force is exerted on the booster body in such a way that the booster body is adjusted with the aid of the brake-boosting force;

positioning a first piston rod component at a first contact surface of the booster body or at a first connecting component contacting the first contact surface of the booster body in such a way that during operation of the brake booster device the brake-boosting force is at least partially transmitted to the first piston rod component in such a way that the piston rod component is adjusted;

additionally positioning a second piston rod component at a second contact surface of the booster body or at a second connecting component contacting the second contact surface of the booster body in such a way that during operation of the brake booster device the brake-boosting force is at least partially transmitted to the second piston rod component in such a way that the second piston rod component is adjusted, together with the first piston rod component; and

exerting a driver braking force on a brake actuation element in order to transmit the driver braking force to an input rod component, the driver braking force bypassing the booster body, wherein:

the driver braking force is applied to the first piston rod component via the input rod component while the input rod component bypasses the booster body.

11. The method of claim **10**, further comprising:

mounting the brake booster device on a brake master cylinder.

12. The method of claim **11**, wherein at least one brake circuit is configured at the brake master cylinder.

13. The brake booster device as recited in claim **1**, wherein the input rod component extends through a bore of the booster body and is movable relative to the booster body along the bore.

14. The power booster as recited in claim **6**, wherein the input rod component extends through a bore of the booster body and is movable relative to the booster body along the bore.

15. The method as recited in claim **10**, wherein the driver braking force translates the input rod component within a bore of the booster body.

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